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Architectures for Decision Analysis

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Overview

- Goals
- The “Big Picture” Military Enterprise
- Methodologies Overview
  - Architecture Development (DoDAF)
  - Decision Analysis (DAF)
  - Cost Analysis (WBS)
- Methodology Integration
  - Semantics
  - Ontological Example
- Synergy & Benefits

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Goals

- Understand the “big picture” military enterprise
- Understand methodologies working within this enterprise
  - Architecture Development (DoDAF)
  - Decision Analysis (DAF)
  - Cost Analysis (WBS)
- Integrate the methodologies into a common analytical approach
- Appreciate the benefits of methodology integration
- Active discussion

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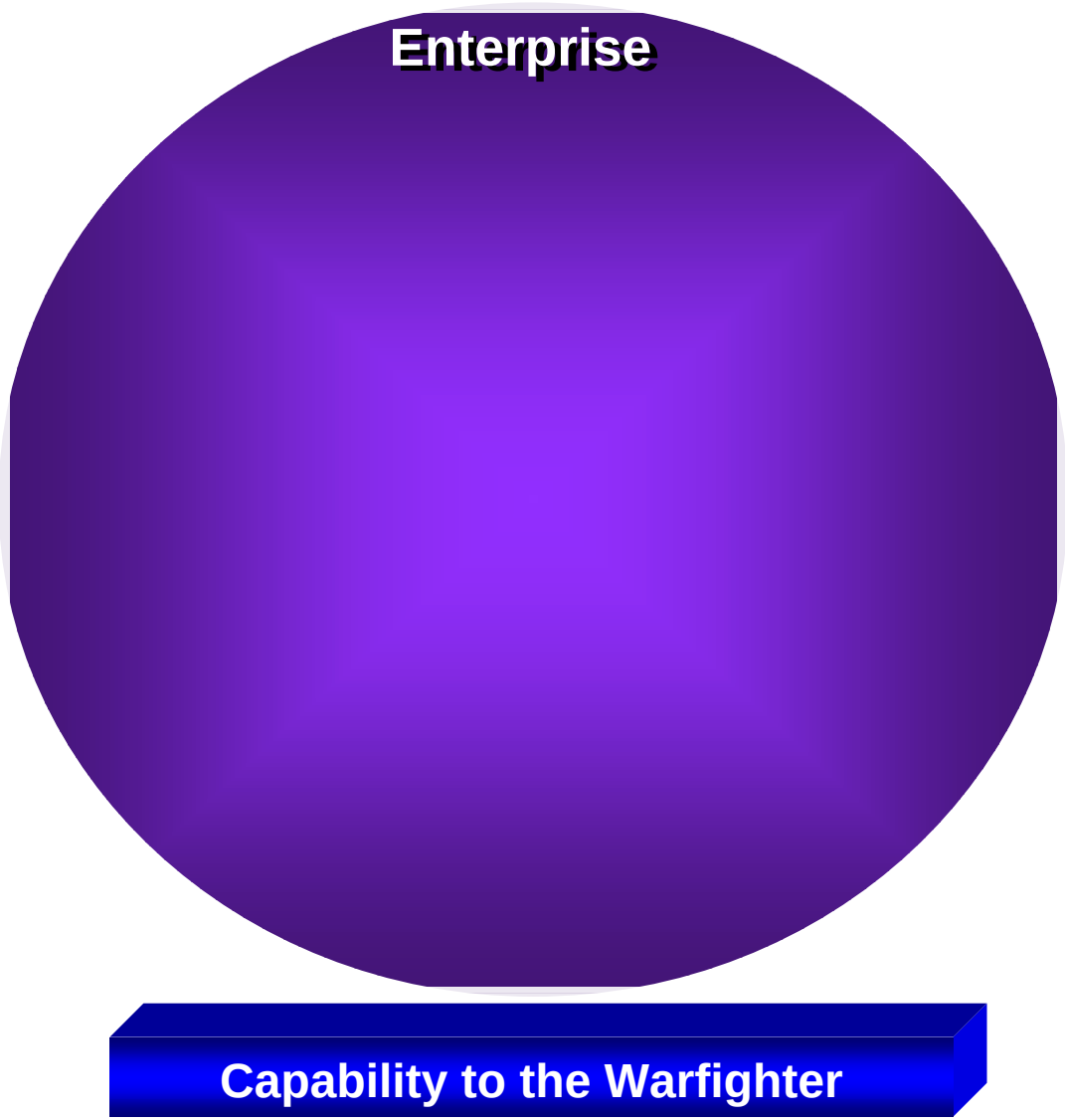
The “Big Picture” Military Enterprise



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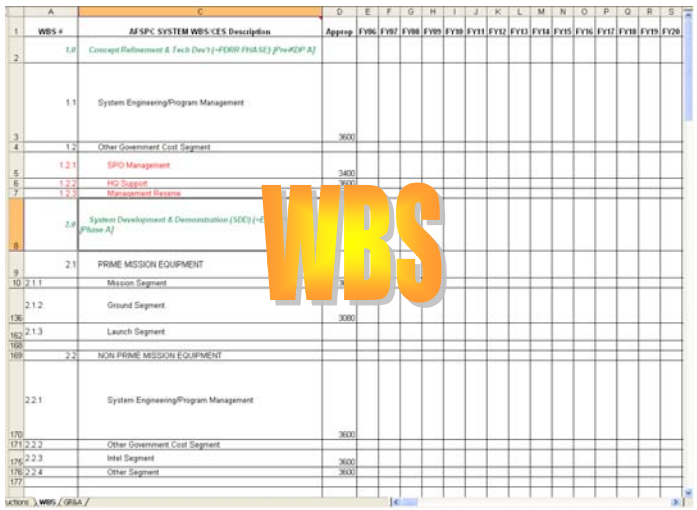
Methodologies Overview



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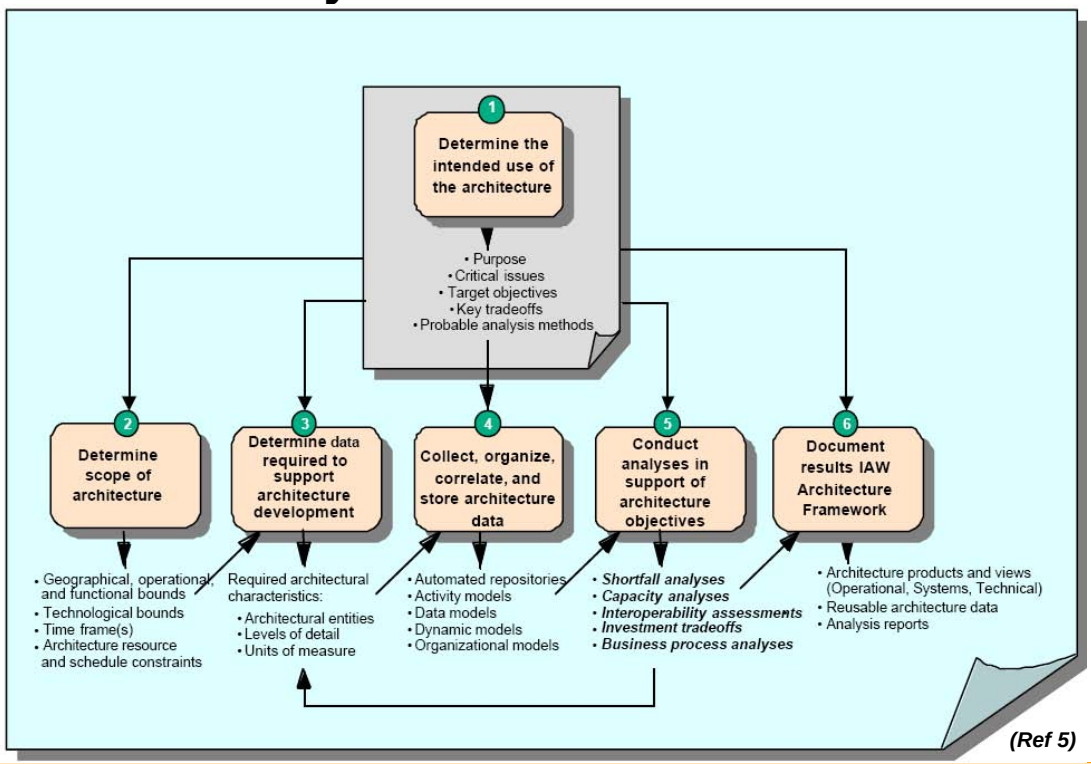
DoD Architecture Framework (DoDAF) Methodology Overview

- **Operations focus - identifies required processes and resources for a specific set of operations**
- **Data-centric**
  - **Structured analysis**
  - **Object-oriented analysis**



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Architecture Products Supporting Analysis

Applicable View	Framework Product	Framework Product Name	General Description
All Views	AV-1	Overview and Summary Information	Scope, purpose, intended users, environment depicted, analytical findings
All Views	AV-2	Integrated Dictionary	Architecture data repository with definitions of all terms used in all products
Operational	OV-1	High-Level Operational Concept Graphic	High-level graphical/textual description of operational concept
Operational	OV-2	Operational Node Connectivity Description	Operational nodes, connectivity, and information exchange needlines between nodes
Operational	OV-3	Operational Information Exchange Matrix	Information exchanged between nodes and the relevant attributes of that exchange
Operational	OV-4	Organizational Relationships Chart	Organizational, role, or other relationships among organizations
Operational	OV-5	Operational Activity Model	Capabilities, operational activities, relationships among activities, inputs, and outputs; overlays can show cost, performing nodes, or other pertinent information
Operational	OV-6a	Operational Rules Model	One of three products used to describe operational activity—identifies business rules that constrain operation
Operational	OV-6b	Operational State Transition Description	One of three products used to describe operational activity—identifies business process responses to events
Operational	OV-6c	Operational Event-Trace Description	One of three products used to describe operational activity—traces actions in a scenario or sequence of events
Operational	OV-7	Logical Data Model	Documentation of the system data requirements and structural business process rules of the Operational View
Systems	SV-1	Systems Interface Description	Identification of systems nodes, systems, and system items and their interconnections, within and between nodes
Systems	SV-2	Systems Communications Description	Systems nodes, systems, and system items, and their related communications lay-downs
Systems	SV-3	Systems-Systems Matrix	Relationships among systems in a given architecture; can be designed to show relationships of interest, e.g., system-type interfaces, planned vs. existing interfaces, etc.
Systems	SV-4	Systems Functionality Description	Functions performed by systems and the system data flows among system functions
Systems	SV-5	Operational Activity to Systems Function Traceability Matrix	Mapping of systems back to capabilities or of system functions back to operational activities
Systems	SV-6	Systems Data Exchange Matrix	Provides details of system data elements being exchanged between systems and the attributes of that exchange
Systems	SV-7	Systems Performance Parameters Matrix	Performance characteristics of Systems View elements for the appropriate time frame(s)
Systems	SV-8	Systems Evolution Description	Planned incremental steps toward migrating a suite of systems to a more efficient suite, or toward evolving a current system to a future implementation
Systems	SV-9	Systems Technology Forecast	Emerging technologies and software/hardware products that are expected to be available in a given set of time frames and that will affect future development of the architecture
Systems	SV-10a	Systems Rules Model	One of three products used to describe system functionality—identifies constraints that are imposed on systems functionality due to some aspect of systems design or implementation
Systems	SV-10b	Systems State Transition Description	One of three products used to describe system functionality—identifies responses of a system to events
Systems	SV-10c	Systems Event-Trace Description	One of three products used to describe system functionality—identifies system-specific refinements of critical sequences of events described in the Operational View
Systems	SV-11	Physical Schema	Physical implementation of the Logical Data Model entities, e.g., message formats, file structures, physical schema
Technical	TV-1	Technical Standards Profile	Listing of standards that apply to Systems View elements in a given architecture
Technical	TV-2	Technical Standards Forecast	Description of emerging standards and potential impact on current Systems View elements, within a set of time frames

All Views (AVs)

What are the assumptions or constraints for this architecture?

Are we all talking about the same thing here?

Operational Views (OVs):

- What does the operational picture **look** like?
- **What are my operational nodes? What information is required?**
- Who is responsible?
- What activities need to happen to realize the operational picture? What are the constraints to the activities?

System Views (SVs):

- **What systems do we need?** What are the interfaces between the systems?
- Unnecessary overlap in system functionality?
- What are the system limitations?
- What are the required system sequences?
- What technology does the system rely on?

Technical Views (TVs):

- What technical standards apply to my systems?

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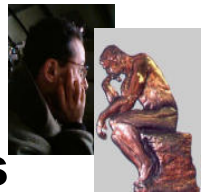
Decision Analysis Methodology Overview



- Decision defined as an irrevocable allocation of resources
  - Decision maker has authority over the resources
  - Decision analysis prescribes a recommended alternative
    - Via a mathematical and logical process
    - Within the context of a decision situation
- Characterizing a decision situation
  - Objectives
    - What decision maker wants to achieve by making the decision
  - Outcomes
    - What an alternative is expected to achieve
  - Alternatives
    - Feasible allocations of resources
- Final insights
  - Alternative predicted outcomes
  - Outcomes related to attainment of objectives
  - How uncertainties in the analysis affect the recommendation

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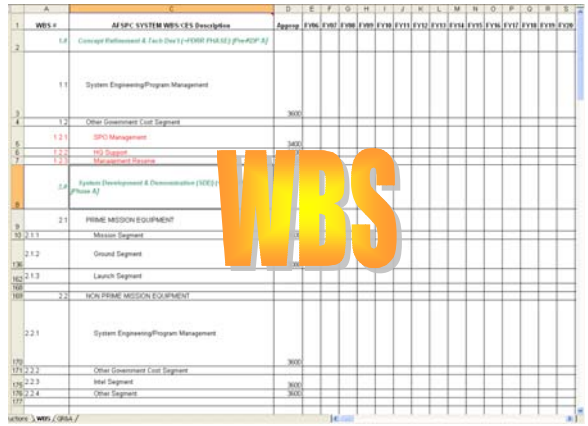
Cost Methodology Overview

- Cost analysis spans entire system lifecycle
- System Work Breakdown Structure (WBS)
  - Composed of subsystems
  - Costs assessed per “scenario”
    - Mission
    - Ground
    - Launch
- Focused on operations & support phase



System Lifecycle

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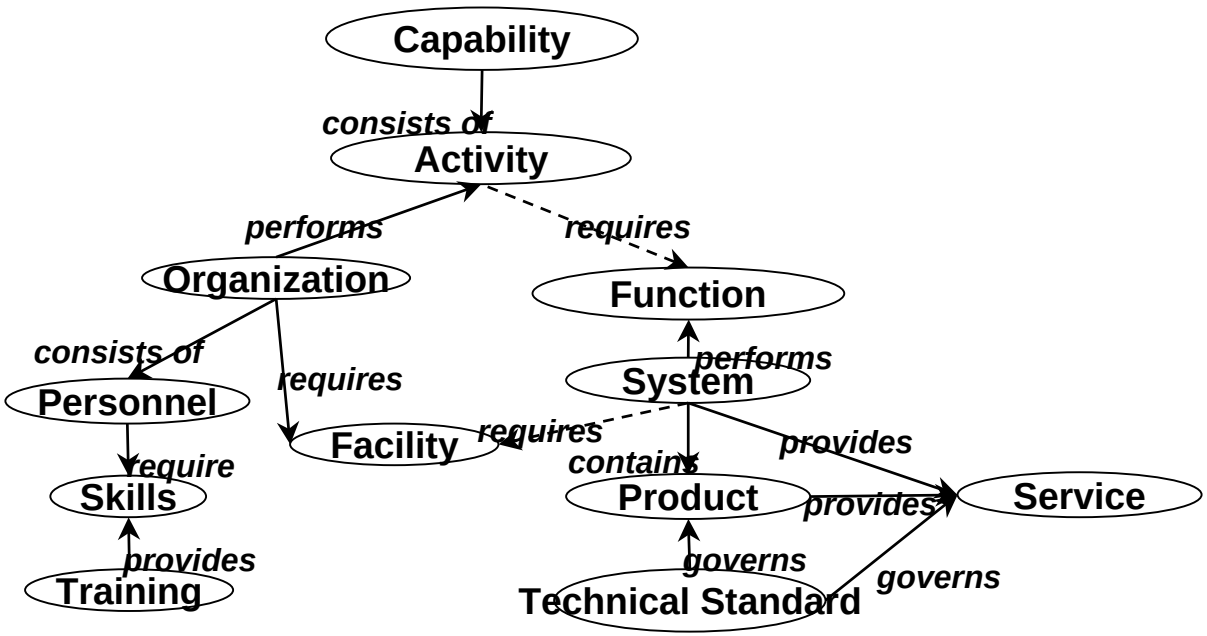
Methodology Integration

- Semantics - “the study of meanings…”[2]
- Terms of Reference
  - Ontology
    - “…a specification of a conceptualization”[3]

Example Ontology



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Methodology Integration (Cont.)

- Terms of Reference (Cont.)
  - Resources
    - people, equipment, systems, money
  - Capability - the ability to execute a specified course of action[1]
  - Activity - a unit, organization, or installation performing a function or mission[1]
  - Organization - a formal group of people with one or more shared goals
  - Personnel - those individuals required in either a military or civilian capacity to accomplish the assigned mission[1]
  - Skills - great ability or proficiency; expertness that comes from training, practice, etc.
  - Training - the teaching of vocational or practical and relates to specific useful skills
  - Facility - A real property entity consisting of one or more of the following: a building, ***a structure***, a utility system, pavement, and underlying land[1]

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Methodology Integration (Cont.)

- Function - what something is used for
- System - All of the devices and organizations forming the space network. These consist of: spacecraft; mission packages(s); ground stations; data links among spacecraft, mission or user terminals, which may include initial reception, processing, and exploitation; launch systems; and directly related supporting infrastructure, including space surveillance and battle management and/or command, control, communications and computers[1]
- Product - the sum of all physical, psychological, symbolic, and service attributes
- Standard - common or compatible technical procedures and criteria[1]
- Service - an act of help or assistance

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Example Ontology Modeling Approach

- Ontology Basics
  - Created through iteration
  - Existing entities should not need to be modified
  - Can add new entities
- "Thin slicing" approach
  - First-order look, "gut feel"
  - Caution: "…bad becoming normal."[4]
- Not nodal analysis
- Not trying to be all inclusive
- All constraints not identified

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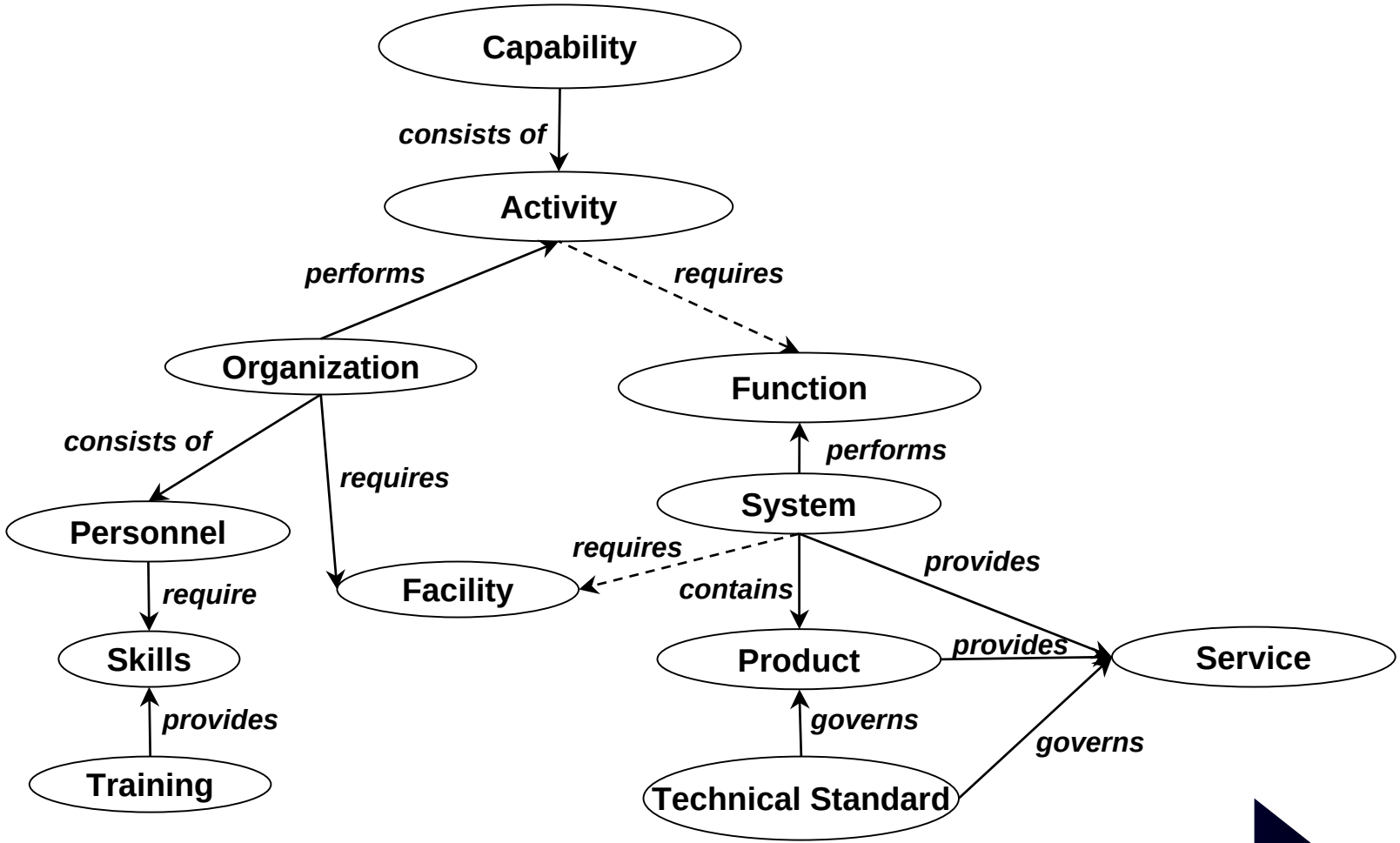
Example Ontology



Concept Refinement | Technology Development | System Dev & Demonstration | Production & Deployment | Operations & Support

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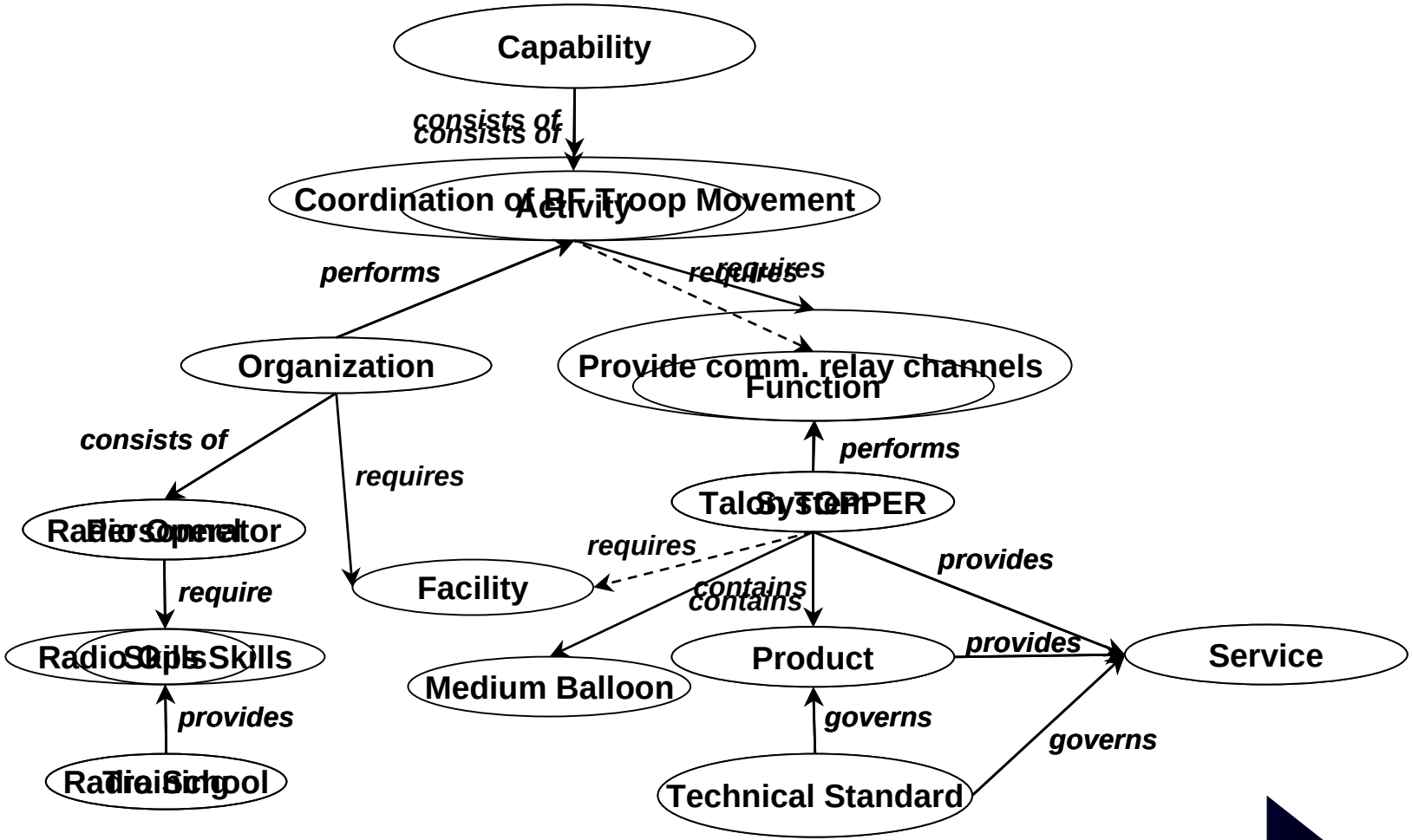
Near-Space Example



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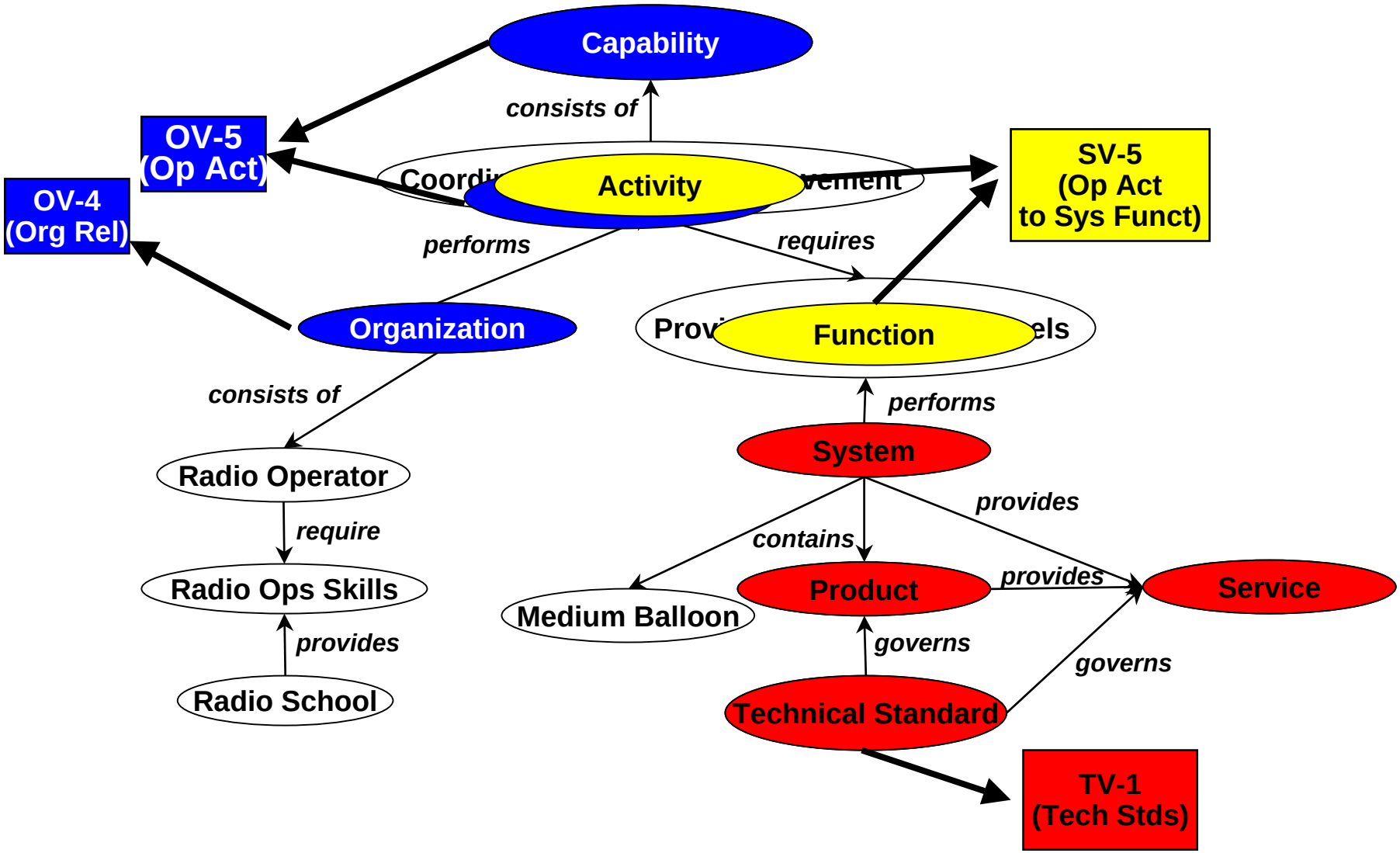
Near Space Example – DoDAF Perspective



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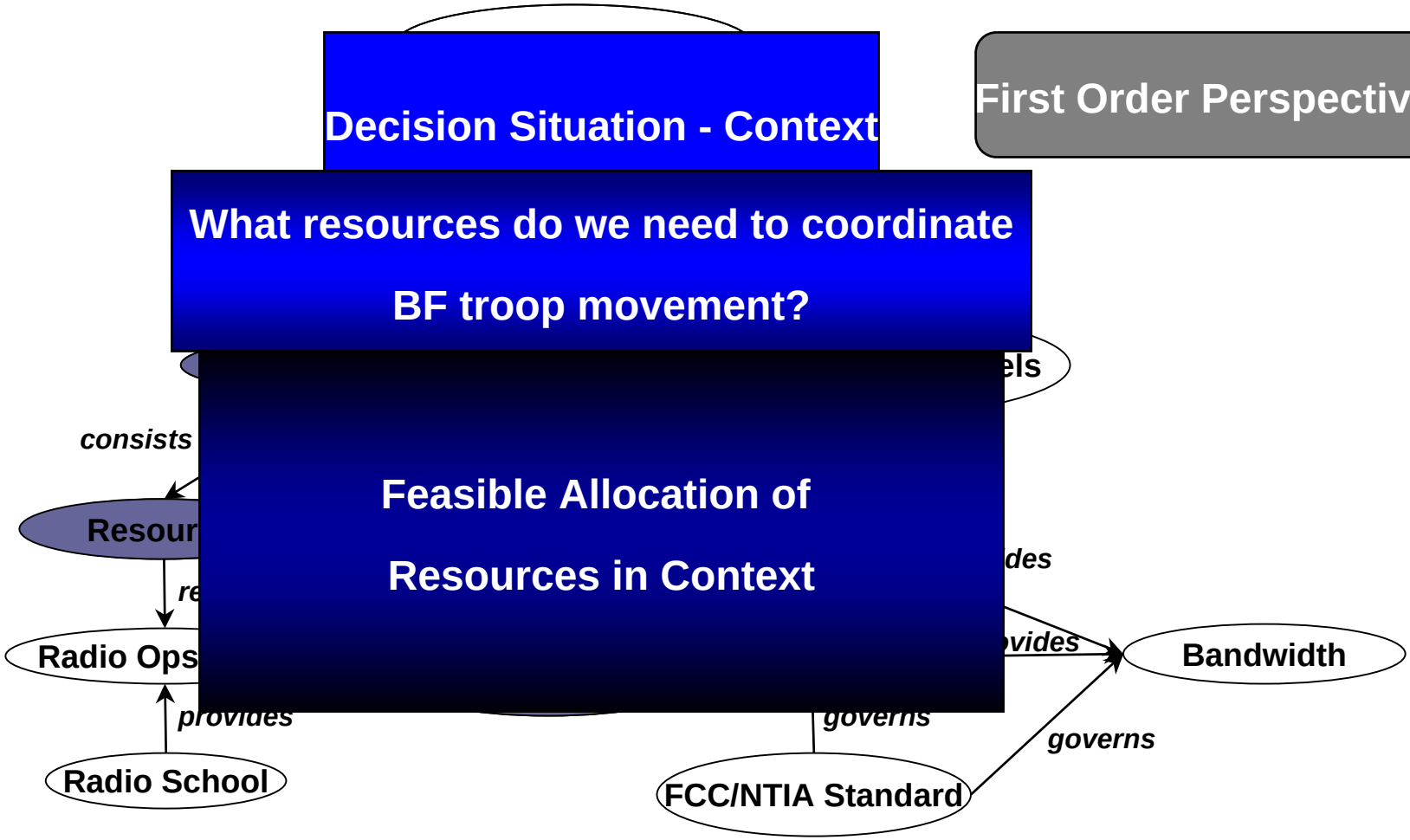
Near Space Example – Decision Analysis Perspective



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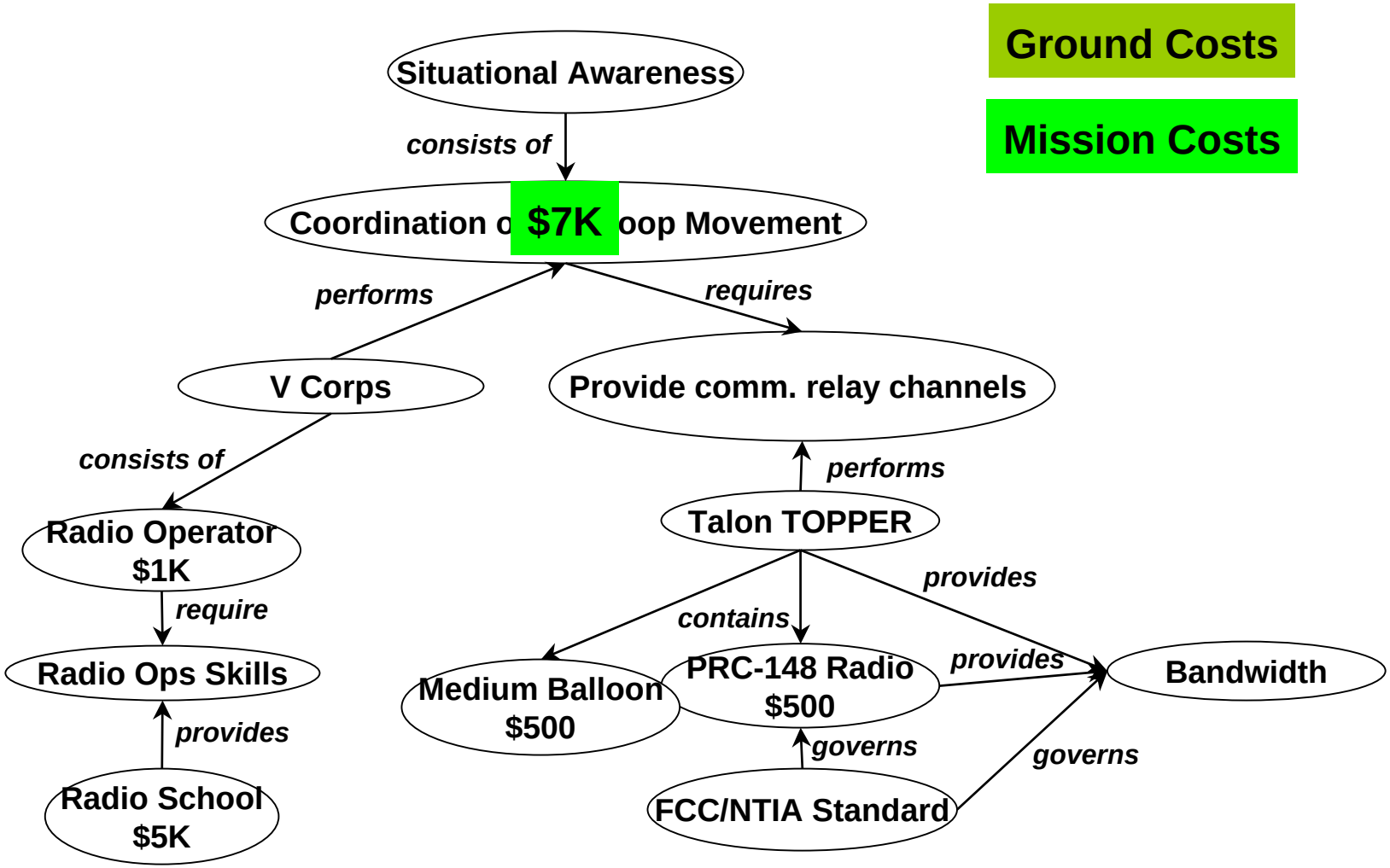
Near Space Example – Cost Perspective



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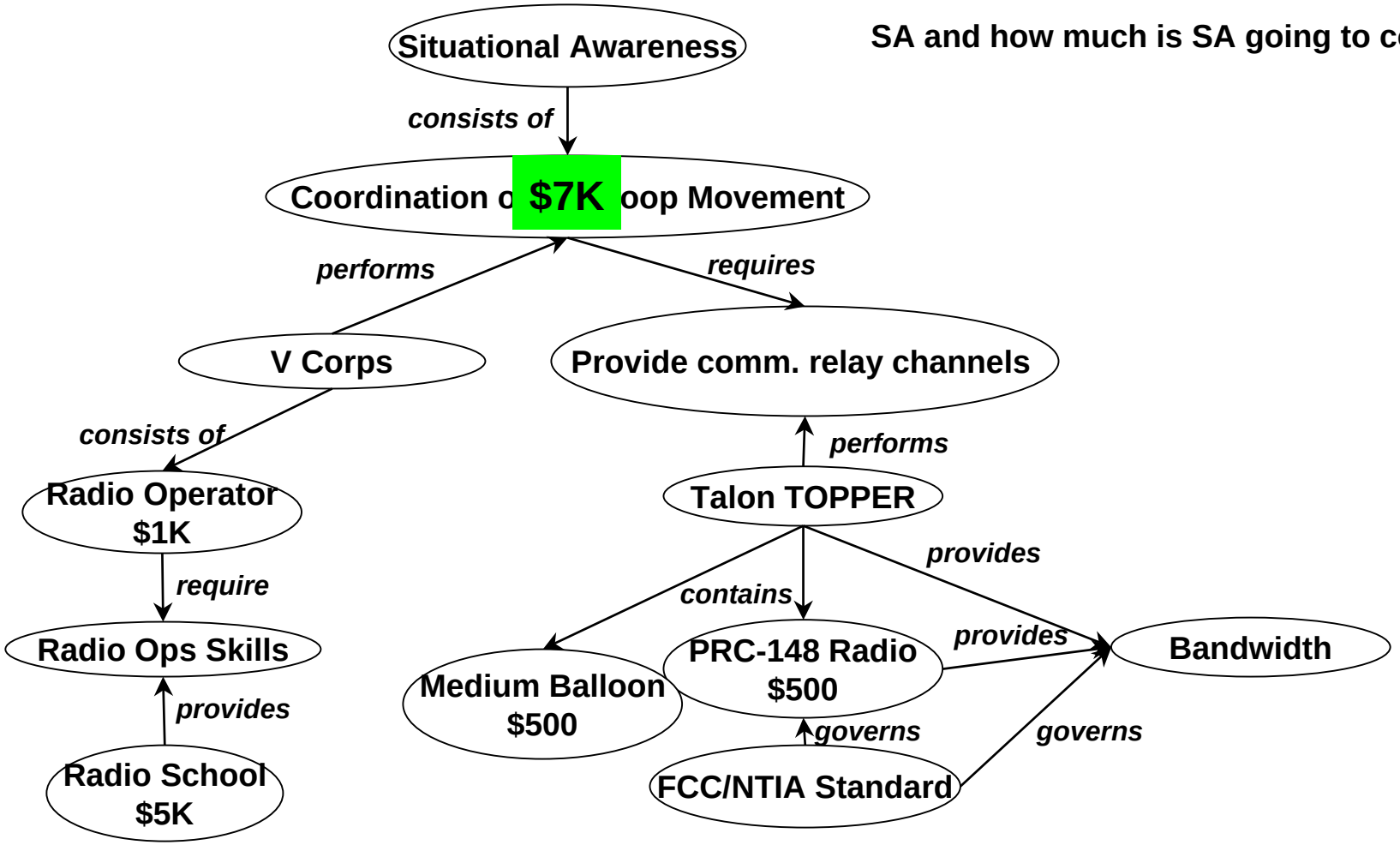
Synergy & Benefit

Who is providing SA, what are they doing to provide SA and how much is SA going to cost?



Query in context = more informed decision making

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Summary

- Creating and using an ontology focused on warfighter capabilities and integrated multi-discipline methodologies can provide continuity throughout an enterprise to facilitate more informed decision making
- Discussion!!!
  - Can this be done better?
  - Is it worth it to integrate each methodology?

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Backups

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